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CONDITIONED REINFORCEMENT OF HUMAN OBSERVING BEHAVIOR BY DESCRIPTIVE AND ARBITRARY VERBAL STIMULI

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College students earned monetary reinforcers by pressing a key according to a compound schedule with variable-interval and extinction components. Pressing additional keys occasionally produced displays of either of two verbal stimuli; one was uncorrelated with the schedule components, and the other was correlated with the extinction component. In Experiments 1 and 2, the display area of the apparatus was blank unless an observing key was pressed, whereupon a descriptive message appeared. Most students preferred an uncorrelated stimulus stating that "Some of this time scores are TWICE AS LIKELY as normal, and some of this time NO SCORES can be earned" over a stimulus stating that "At this time NO SCORES can be earned." In Experiment 3, the display area indicated that "The Current Status of the Program is: NOT SHOWN." Presses on the observing keys replaced this message with stimuli that provided arbitrary labels for the schedule conditions. All of the students preferred a stimulus stating that "The Current Status of the Program is: B" over an uncorrelated stimulus stating that "The Current Status of the Program is: either A or B." Thus, under some circumstances, observing was maintained by a stimulus correlated with extinction—a finding that poses a challenge for Pavlovian accounts of conditioned reinforcement. Differences in the maintenance of observing by the descriptive and arbitrary stimuli may be attributed to differences in either the strength or nature of the instructional control exerted by the verbal stimuli.

Key words: conditioned reinforcement, observing, instructions, S−, uncorrelated stimulus, delay-reduction hypothesis, information, response effort, key press, college students

A stimulus may function as a conditioned reinforcer because of a history of association with previously established reinforcers such as food, water, or money. Prominent theoretical accounts are based on the view that the principles of conditioned reinforcement parallel those of Pavlovian conditioning (Dinsmoor, 1983; Fantino, 1977; Kelleher & Gollub, 1962; Mackintosh, 1974). A well-supported version is Fantino's (1977) delay-reduction hypothesis, which holds that the conditioned properties of an initially neutral stimulus depend on the average time to primary reinforcement in its presence relative to its absence. Three provisions are relevant: (a) If the stimulus is correlated with a reduction in time to primary reinforcement, it should function as a conditioned reinforcer. (b) If the stimulus is correlated with increased time to reinforcement, it should function as a conditioned punisher. (c) In the absence of a differential association with primary reinforcement, the stimulus should remain neutral.

A major tool for studying such conditioned properties is the "observing response" procedure (Wyckoff, 1952), in which a designated response produces stimuli correlated with the components of a compound schedule of primary reinforcement. Maintenance or suppression of observing reflects the conditioned reinforcing or punishing properties of the stimuli (Dinsmoor, 1983). For example, consider a schedule with alternating components of reinforcement and extinction (EXT). In line with the delay-reduction hypothesis, experiments with pigeons have shown that the stimulus correlated with reinforcement (S+) maintains observing (e.g., Blanchard, 1975; Browne & Dinsmoor, 1974; Dinsmoor, Browne, & Lawrence, 1972; Jenkins & Boakes, 1973; Kamin-

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ski & Moore, 1990; Katz, 1976; Kendall, 1973; Killeen, Wald, & Cheney, 1980; Mueller & Dinsmoor, 1984, 1986; Mulvaney, Dinsmoor, Jwaideh, & Hughes, 1974), whereas the stimulus correlated with EXT (S−) suppresses it (Blanchard, 1975; Mueller & Dinsmoor, 1986, Experiment 3; Mulvaney et al., 1974), and uncorrelated stimuli are relatively ineffective (e.g., Katz, 1976; Wilton & Clements, 1971; Wyckoff, 1969).

Although research with pigeons favors Pavlovian accounts, research with humans has been less clear, with controversy regarding the functions of S−. Contrary to Pavlovian accounts and experimental evidence from pigeons, Perone and Baron (1980) found that S− maintained observing in their adult human subjects. By comparison, Fantino, Case, and their colleagues found that S− did not maintain observing, except possibly under special circumstances (also see Mulvaney, Hughes, Jwaideh, & Dinsmoor, 1981).

Perone and Baron's (1980) research closely followed procedures developed for pigeons by Mulvaney et al. (1974). Young men worked on a compound schedule of monetary reinforcement with variable-interval (VI) and EXT compounds. In the critical conditions, the components were unsignaled (i.e., a mixed schedule was in effect) unless the men pressed either of two concurrently available observing keys. Pressing one key occasionally produced brief displays of S+ or S−, depending on the ongoing component. Pressing the other key occasionally produced S+ during the VI component, but produced no stimulus during EXT. The men preferred the key that produced both stimuli over the key that produced only S+, and this preference was maintained when the roles of the keys were interchanged, showing that the addition of S− enhanced observing rates compared with those maintained by S+ alone. Subsequent manipulations confirmed the reinforcing value of S− by showing that it maintained observing even when it was the sole consequence. Perone and Baron pointed to the reliable, albeit negative, relation between S− and money, and suggested that the informative nature of S− may have been the key to its reinforcing value.

Attempts to reconcile Perone and Baron's (1980) findings with Pavlovian accounts sought procedural artifacts that could have established S− as a reinforcer through familiar mechanisms. Fantino, Case, Dinsmoor, and others recently claimed to have found the artifact in the relatively high degree of effort required by the schedule of monetary reinforcement (e.g., Case, Fantino, & Wixted, 1985; Dinsmoor, 1983). Perone and Baron's subjects had to pull a plunger with 22 N of force to earn money; by comparison, to produce the discriminative stimuli, they had only to press observing keys requiring less than 1 N. If plunger responding was aversive, then its suspension in the EXT component should have been reinforcing, and the stimulus correlated with suspension (S−) should have become a conditioned reinforcer by association. (Comparable effects are thought to be absent in pigeons because of the low effort of the key-peck response; Dinsmoor, 1983, p. 719.)

In several experiments by Fantino and Case's group (Case & Fantino, 1989; Case, Ploog, & Fantino, 1990; Fantino & Case, 1983; Fantino, Case, & Altus, 1983), the role of effort was eliminated by presenting established reinforcers (usually money) independently of responding, through the use of a mixed schedule with variable-time (VT) and EXT components. Pressing one observing key occasionally produced brief displays of S− during the EXT component, but produced no stimulus during the VT component. Pressing another key occasionally produced a stimulus that was uncorrelated with the components. The subjects generally preferred the uncorrelated stimulus over S−. Another experiment repeated the comparison under conditions in which subjects had to earn the money by pulling a plunger (Case et al., 1985, Experiment 2). Although preference appeared to shift from the uncorrelated stimulus to S− when the subjects were considered as a group, *t* tests and binomial tests failed to confirm the statistical significance of the group comparisons (p. 297), so a conservative reading leads to the conclusion that no clear preference was obtained. Overall, then, this line of research casts doubt on the reinforcing efficacy of informative stimuli, in that S− maintained relatively little observing under conditions in which no reduction in response effort could be accomplished via its production. In other words, under conditions of response-independent reinforcement, subjects preferred an uninformative stimulus in whose presence reinforcement did occur (the uncorrelated stimulus) over an informative stimulus in whose presence reinforcement did not occur (S−).

It may be too soon, however, to conclude that human observing behavior is well understood. Careful review of the research by Perone and Baron (1980) and by Fantino and Case's group reveals several important procedural differences besides the response requirements. First, before the observing tests, Perone and Baron (1980) gave their subjects multiple-schedule training to provide extended exposure to the relations between the discriminative stimuli and monetary reinforcers. Fantino and Case's group generally omitted this step and placed subjects directly on the observing procedure. Second, Perone and Baron used a single-subject reversal design in which conditions were continued for an average of 15 sessions each, until responding stabilized, and the stimulus consequences of the two observing keys were reversed to control for response bias as well as to ensure full contact with the consequences. In most cases, Fantino and Case's group conducted each condition for a single session and used group statistics to assess the effects of their manipulations. Third, Perone and Baron gave their subjects minimal instructions about the stimulus–reinforcer relations, establishing stimulus control through direct and repeated exposure to the experimental environment. Fantino and Case's group gave detailed instructions, substituting verbal descriptions of the stimulus–reinforcer relations for significant degrees of direct exposure. (A possible exception is considered in the Discussion section of Experiment 3 below).

In summary, studies of observing in humans have adopted substantially different experimental strategies, and these may have contributed to the conflicting results. Perone and Baron's (1980) strategy closely followed that of animal research: Stimulus functions were engendered through extended exposure to reliable stimulus–reinforcer relations, and steady-state reversal designs were used to demonstrate experimental control at the level of the individual subject. They found that S− functioned as a conditioned reinforcer. By comparison, Fantino and Case's group gave instructions about the stimulus–reinforcer relations in lieu of direct contact and relied on group statistics to evaluate control. They found that S− did not function as a reinforcer.

Research has shown that instructions can override experimental contingencies, especially when contact with the contingencies is minimal (see Baron & Galizio, 1983, for a review). Viewed this way, the limited contact in Fantino and Case's research magnified the opportunity for control by their instructions. As Skinner (1969, pp. 113–117) noted, instructions about experimental relations need not have the same effect as exposure to the relations themselves. These considerations make it difficult to interpret the contribution of Fantino and Case's data to the analysis of conditioned reinforcement.

The purpose of the present research was to clarify the circumstances under which S− might reinforce human observing behavior. Three experiments, all using single-subject reversal designs, evaluated the contributions of verbal messages about stimulus–reinforcer relations and of direct contact with those relations. A high degree of direct contact was provided through exposure to a multiple VI EXT schedule in which stimuli accompanied the components throughout a block of sessions. A lesser degree of contact was provided in the observing conditions, when stimuli could be produced only intermittently and thus were absent during most of each session.

Throughout, the discriminative stimuli were verbal messages presented on a video monitor. In Experiments 1 and 2 the messages were descriptions of the stimulus–reinforcer relations, derived from the instructions used by Fantino and Case's group. For example, S− consisted of a display of the following message: "At this time NO SCORES can be earned." In Experiment 3 the messages bore an arbitrary relation to monetary reinforcement, as in the following S−: "The Current Status of the Program is: B."

The schedules of monetary reinforcement were response dependent, even though such schedules could conceivably allow S− to be correlated with reduced effort. Response-dependent schedules have a significant advantage over response-independent schedules in that they allow assessment of stimulus control by the degree to which responding occurs in the presence of stimuli correlated with reinforcement and extinction. Effort was minimized by using low-force keys on both the stimulus (observing) and money schedules, and the role of effort was held constant by retaining this arrangement throughout the experiments.

GENERAL METHOD

Subjects

College students in introductory psychology courses volunteered to participate in an experiment on human performance and decision making. Data are reported from 8 women (Subjects F1 through F8) and 3 men (M1 through M3), 18 to 22 years old; data from another 2 students are omitted because they failed to observe often enough to permit study. After participating in the first session as a trial, the students gave informed consent by signing a contract to work for as many as 60 hr, scheduled 10 to 20 hr per week. The contract indicated that payment would be made on the basis of performance, with a maximum of about \$2.50 per hour. To discourage subjects from dropping out of the project, the contract described an additional payment of \$100 (Subject F3) or \$2 per hour (remaining subjects) contingent on completing all scheduled sessions.

Apparatus

Each student worked individually in a small room, seated before a response console with a work panel and a computer video monitor. The sloping work panel, 33 cm long and 51 cm wide, contained four translucent response keys (Grason-Stadler No. E8670A), mounted in a horizontal row, and a silver push button labeled "COLLECTION" centered above them. The rightmost response key (main key) was associated with a compound schedule of monetary reinforcement; the two leftmost keys (observing keys) were associated with concurrent schedules of discriminative-stimulus production. The remaining key was not used. The active keys were lit from behind and required a force of 0.5 N to 0.9 N to operate. White masking noise was provided through headphones.

A 12-in. monochrome video monitor, mounted on top of the work panel at eye level, was used to present additional discriminative stimuli, reinforcement messages, and response feedback in green characters on a black background. The discriminative stimuli were presented in two rectangular boxes (5 cm by 21 cm) located at the top and bottom of the video screen. The area between the boxes was used to present response feedback and messages about reinforcement.

Control and recording operations were accomplished with a microcomputer (Tandy, TRS-80 Model 4) connected to the console by a commercial interface (Alpha, Interfacer 80) and electromechanical components, using a software system described elsewhere (Perone, 1985).

Instructions and General Procedure

Before the first session, the student read typewritten instructions about the response console as the experimenter read them aloud. The instructions were minimal, without mention of either the discriminative stimuli or the schedules of money and observing. The aim was to facilitate adjustment to the experimental contingencies, not to prompt any particular response pattern. Therefore, instructions at the outset emphasized that "while a session is in progress, you are in charge of working the apparatus. It is up to you to decide how to operate it to your best advantage." The instructions later reminded the student that "while a session is in progress, you can do whatever you like . . . but remember that your pay depends on what you do."

With regard to the video monitor, the instructions simply indicated that it "will be used to present a variety of signals and messages." With regard to the response keys, the instructions were as follows:

> Notice the four large white push buttons. These buttons work only when they are illuminated. When you push one of the illuminated buttons, you must hold it down for a while in order to let the apparatus register your response. As soon as you push the button, you will see the outline of a small box on the video screen, right above the button. You must continue to hold the button down until the box has filled in. This lets you know that your response has registered. If you let go before the box is filled in, your response will not register. After a brief moment the box will disappear. You have to let go of the button before you can push it again.

These instructions described a delay procedure designed to discourage simultaneous presses on more than one key and thereby maximize the effect of the consequences of pressing a particular key. As soon as a key was pressed, the outline of a 2.2-cm square appeared on the video screen above the key. If the key was held down for 0.30 s, the outline was filled in. After another 0.20 s the square disappeared from the screen, signaling that the press had been completed. Consequences, if scheduled, occurred at this point.

If two keys were pressed simultaneously or if an inoperative (dark) key was pressed, the message "ILLEGAL ACTION" was presented immediately and the work panel was deactivated for 5 s. Presses during this time restarted the deactivation period.

Sessions lasted about 24 min and were scheduled in pairs with a short break in between. A longer break was given between pairs of sessions, during which the student was allowed to leave the work room. Personal items such as watches, books, and writing materials were not allowed in the work room. The typewritten instructions were removed after the first session.

Schedule of Monetary Reinforcement

Throughout each experiment, monetary reinforcement was available through a compound schedule programmed on the main key. In one component, reinforcement occurred on a VI 27-s schedule, with intervals from Fleshler and Hoffman's (1962) series. In the other component, reinforcement never occurred (EXT). To arrange irregular alternation of the components, sessions were broken into 48 segments lasting 30 s each, and components alternated after one to seven segments, with a mean of four. This procedure ensured that the session was divided equally between the VI and EXT components (except on a few occasions early in discrimination training when responding in the EXT component extended the component; see *Discrimination Training* below).

The reinforcement cycle consisted of two parts. First, all of the response keys were darkened and the monitor displayed the message "You scored! Press the collection button." Next, pushing the small silver button centered above the response keys replaced this message with a 2-s presentation of "5 cents has been added to your earnings." Total earnings were displayed on the monitor after each session and a written summary was given each day, but payment was not made until the end of the experiment.

Discrimination Training

Discriminative stimuli accompanied the VI and EXT components during three multiple-schedule conditions. The stimuli were the verbal messages shown in Table 1. Only the main key was lit and operative; both observing keys were dark.

In the mult-correlated condition, one stimulus was correlated with the VI component (S+) and another with the EXT component (S−). These stimuli were presented in the top display box; the bottom display box also appeared on the screen, but it remained empty. The mult-correlated condition was continued until the proportion of responding in the presence of S+ was at least .90 over five consecutive sessions.

So that key pressing in the presence of S− would not be reinforced adventitiously by the

Table 1

Discriminative stimuli used in the three experiments.

Type of stimulus	Function	Text of computer display
Experiments 1 and 2: Descriptive stimuli		
S+	Correlated with VI	At this time scores are TWICE AS LIKELY as normal.
S−	Correlated with EXT	At this time NO SCORES can be earned.
S1	Uncorrelated	Some of this time scores are TWICE AS LIKELY as normal, and some of this time NO SCORES can be earned.
S2	Uncorrelated	Some of this time NO SCORES can be earned, and some of this time scores are TWICE AS LIKELY as normal.
MIX	Uncorrelated	[Stimulus box was blank.]
Experiment 3: Arbitrary stimuli		
S+	Correlated with VI	The Current Status of the Program is: A
S−	Correlated with EXT	The Current Status of the Program is: B
S1	Uncorrelated	The Current Status of the Program is: either A or B
S2	Uncorrelated	The Current Status of the Program is: either B or A
MIX	Uncorrelated	The Current Status of the Program is: NOT SHOWN

Note. The S+ and S− messages were displayed in a box appearing in the upper third of the screen; S1 and S2 were displayed in an identical box in the lower third.

onset of S+, offset of the EXT component was prevented within 15 s of such responding. To prevent responding in the EXT component from extending the session indefinitely, sessions were limited to a maximum of 25 min. The delay was temporarily increased to 60 s for 2 students, F3 (Experiment 1) and F8 (Experiment 3), because they continued to respond at substantial rates in the presence of S−. The increased delay remained in effect until discriminated responding developed, when it was returned to 15 s. The delay procedure was operative whenever S− was displayed, throughout the experiment, except in the mult-simultaneous condition (described below) when it was omitted by mistake.

In the mult-uncorrelated condition, two stimulus messages (designated S1 and S2) alternated in the bottom display box at the same rate as the VI and EXT components, but were independent of them. The top display box was empty. To arrange irregular alternation of the uncorrelated stimuli, sessions were broken into 48 segments lasting 30 s each, and the "stimulus components" alternated after one to seven segments, with a mean of four. The mult-uncorrelated condition was continued until the proportion of responses in the presence of S1 was .50 ± .10, with no increasing or decreasing trend over five consecutive sessions.

In the final stage of discrimination training, the mult-simultaneous condition, the correlated and uncorrelated stimuli were presented at the same time. The correlated stimuli (S+, S−) were presented in the top display box, and the uncorrelated stimuli (S1, S2) were displayed in the bottom box. The mult-simultaneous condition was continued until the criterion for the mult-correlated condition had been met; that is, until at least 90% of responses occurred while S+ was present.

Observing Conditions

Observing behavior was studied under mixed-schedule conditions in which the discriminative stimuli were absent and the display boxes either were blank (Experiments 1 and 2) or indicated that the current status of the program was "not shown" (Experiment 3; see Table 1). Presses on the two observing keys, now lit and operative, occasionally produced 10-s presentations of the stimuli according to independent VI 20-s schedules (Fleshler & Hoffman, 1962). During stimulus presentations, the observing keys were dark and inoperative and the concurrent observing schedules were suspended. So that observing would not be followed closely by monetary reinforcers, presentation of these reinforcers was blocked within 2 s of an observing response.

Different stimulus consequences were associated with the observing keys. Presses on one key could produce stimuli only when the EXT component was in effect; that is, presses could produce only S−. Presses had no consequence during the VI component, and if the schedule component changed from EXT to VI during a presentation of S−, the remainder of the presentation was canceled. Presses on the other key could produce S1 when it was available but had no consequence when S2 was available. Availability of S1 and S2 was determined by the sequence of uncorrelated "stimulus components" (see *Discrimination Training,* above). If the component changed from S1 to S2 during a stimulus presentation, the remainder of the S1 presentation was canceled. Thus, presses on one observing key occasionally produced S−, whereas presses on the other occasionally produced S1. As in discrimination training, S− was presented in the top display box and S1 in the bottom; while either stimulus was present, the unused display box was empty.

Each observing condition was continued until there was no increasing or decreasing trend in the proportion of presses on the key producing S−, and the same key was preferred, for five consecutive sessions or until an upper limit of 16 sessions was reached.

EXPERIMENT 1

In a series of experiments with college students (Case & Fantino, 1989, Experiments 1 and 2; Case et al., 1985, Experiment 2; Case et al., 1990; Fantino & Case, 1983), Fantino and Case gave instructions about the stimulus–reinforcer relations in the following language (with only minor changes across experiments):

> In front of you are two levers and some lights. The white light will normally be on. You can occasionally cause the blue or red lights to turn on by pressing the levers. When the blue light is on, some of the time points are twice as likely as normal. However, at other times when the blue light is on, no points will be earned. In

> contrast, no points will be earned when the red light is on. (Fantino & Case, 1983, p. 196)

Fantino and Case characterized these instructions as "correctly [describing] the relationship of the stimuli to reinforcement" (1983, p. 196); in this case, the blue light was uncorrelated with the components of a mixed VT EXT schedule and the red light was correlated with the EXT component. But by our reading, the instructions imply a causal relation between observing the blue light (uncorrelated stimulus) and receiving points, as well as between observing the red light (S−) and the absence of points. Viewed this way, the instructions would be expected to prompt an immediate preference for the uncorrelated stimulus. This, of course, is the result that Fantino and Case reported.

Instructional control can be reduced when responding comes into contact with experimental contingencies (Galizio, 1979). Unfortunately, as noted in the introduction, the degree of contact with the stimulus–reinforcer relations in Fantino and Case's research generally was low. Subjects were usually exposed to each condition for just one half-hour, during which they saw the stimuli only occasionally, as allowed by their responding on the intermittent observing schedules. Perhaps stimulus preferences might have been different—and more in line with those obtained by Perone and Baron (1980)—had the subjects been given more extensive experience. To address this issue, Experiment 1 investigated the maintenance of observing by verbal stimuli derived from Fantino and Case's instructions, both before and after extended contact with the stimulus–reinforcer relations.

Method

Four students (3 women and 1 man) participated. The upper panel of Table 1 presents the verbal messages used as discriminative stimuli, which were adapted from the instructions used by Fantino and Case (1983). The initial phase consisted of a set of observing conditions: In the first condition, one key produced S− and the other produced S1; in the second, the consequences were reversed. Responding stabilized in 5 to 15 sessions in the first case and in 6 to 15 in the second. Next was discrimination training, with a block of sessions devoted to each of three conditions: mult-correlated (5 to 17 sessions), mult-uncorrelated (5 to 17 sessions), and mult-simultaneous (6 to 14 sessions). Finally, another set of observing conditions was conducted, with the stimulus consequences of the left and right keys (S− vs. S1) repeatedly reversed across blocks of sessions until a clear preference was evident. Each of these conditions lasted 5 to 16 sessions.

Results

Observing Responses

Stimulus preferences are indicated by relative rates of responding on the two observing keys. Because of the present interest in the functions of S−, the rates are expressed as the proportion of total responses made on the S− key. Relative rates consistently above .50 indicate preference for S−, whereas rates consistently below .50 indicate preference for S1. Shifts in relative rates as a function of stimulus/key reversals indicate bias toward responding on one of the keys.

Figure 1 presents the relative rates before and after discrimination training, with data from the last five sessions of each observing condition. Before discrimination training, 2 of the 4 students (F1 and F2) preferred S1 in the initial condition; these preferences continued during the second condition when the roles of the keys were reversed. The other 2 students (F3 and M3) had no stimulus preference before discrimination training, showing instead a bias for the right key regardless of its consequence. After discrimination training, F1 and F2 continued to prefer S1, and the other 2 students showed reversible preferences for S1 as well.

Table 2 presents the absolute rates of observing and the time that S− and S1 were present as a consequence. The means and standard deviations are based on the last five sessions of each condition in the final pair of observing conditions before and after discrimination training. Thus, each summary statistic is based on 10 sessions and collapses across the stimulus/key reversals. Although observing was maintained throughout the experiment, the absolute rates tended to be lower after discrimination training. In part because of the intermittent observing schedules, which limited production of S− and S1 to 4 min per session (each), all 4 subjects spent at least 75%

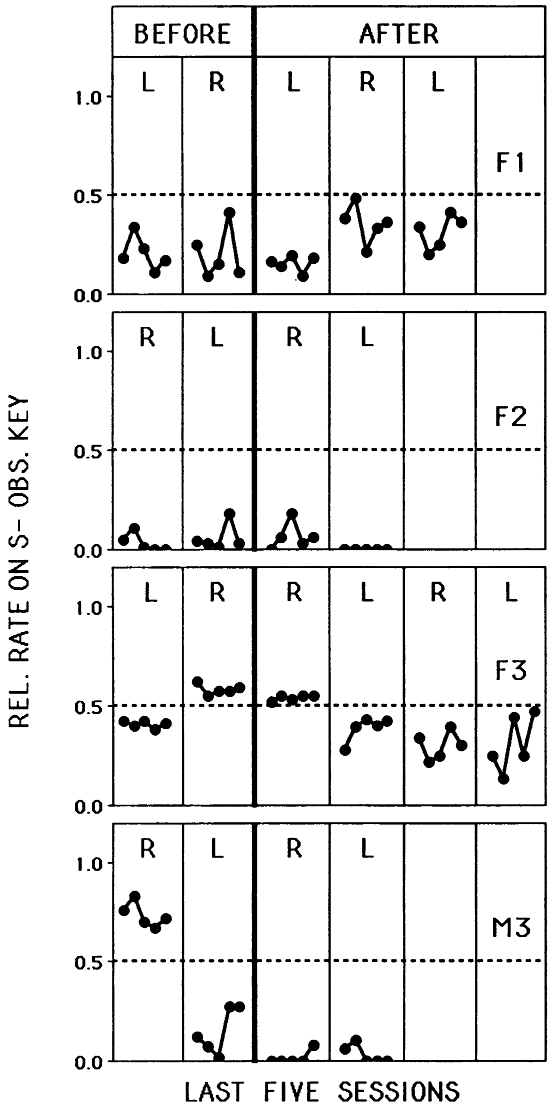

Fig. 1. Experiment 1: Relative rates on the observing key leading to S− (rates on the S− key divided by the sum of rates on the S− and S1 keys) over the last five sessions of each condition before and after discrimination training. Conditions are shown in order of exposure for each subject; the key leading to S− (left or right) is designated in each panel.

of the time in the absence of these stimuli (i.e., in the presence of the MIX stimulus). Before discrimination training, Subjects F1 and F2 produced S1 for substantially more time than S−. This pattern continued after discrimination training. Subjects F3 and M3 produced the two stimuli about equally before discrimination training. Afterwards, F3 continued to produce the stimuli equally, whereas M3 produced S1 for more time than S−.

Main-Key Responses

Figure 2 and Table 3 present absolute rates of responding on the main response key for the last five sessions of each condition in the discrimination training phase. Rates were well differentiated in the presence of S+ and S− and about equal in the presence of S1 and S2, regardless of whether the pairs of stimuli were presented alone (mult-correlated and mult-uncorrelated conditions) or in combination (mult-simultaneous condition).

During the observing conditions, when the stimuli appeared intermittently, main-key response rates in the presence of S1 were substantial throughout the experiment, whereas rates in S− varied across phases. As shown in Table 2, before discrimination training Subjects F2, F3, and M3 responded at relatively high rates in S−. In the subsequent set of observing conditions, however, the low rates established during the multiple-schedule conditions were maintained. (As a minor exception, note that M3 failed to produce S− and thus could not respond in its presence.)

Stimulus–Reinforcer Relations

Table 4 shows the rate of monetary reinforcement in the presence of the correlated and uncorrelated stimuli during discrimination training. The procedures were successful in exposing the students to the desired stimulus–reinforcer relations, with obtained reinforcement rates close to the programmed rates: zero in the presence of S−, about two reinforcers per minute in S+, and about one per minute in S1 and S2.

Information on the rates of monetary reinforcement in the observing conditions can be found in Table 2. Rates during the MIX stimulus averaged about one reinforcer per minute. The rates during S1 tended to be slightly higher, but this is an artifact of averaging rather than a reliable difference. As shown by the standard deviations in Table 2, the S1 rates were quite variable from session to session; the local rates of monetary reinforcement fluctuated widely, depending on whether the intermittent, response-produced displays of S1 happened to occur during the VI or EXT component. Statistical analyses comparing the S1 and MIX rates were conducted separately

Table 2

Observing rates (responses per minute), time spent in the presence of the stimuli (in minutes), and main-key rates and monetary reinforcement rates in the presence of the stimuli. Observing rates were calculated by dividing the number of responses by the time the keys were active (i.e., during MIX stimulus conditions). Shown are means (standard deviations in parentheses) collapsed across the last five sessions in each of the final two observing conditions before and after discrimination training (for a total of 10 sessions per statistic).

Experiment	Subject	Phase	Observing rate		Stimulus time			Main-key rate			Reinforcement rate		
			S− key	S1 key	S−	S1	MIX	S−	S1	MIX	S−	S1	MIX
1	F1	Before	6.7	27.0	2.0	3.3	18.8	0.6	75	40	—	0.95	1.04
			(3.4)	(5.8)	(0.4)	(0.4)	(0.5)	(0.6)	(4)	(7)	—	(0.43)	(0.15)
		After	10.2	20.5	2.7	3.2	18.2	0.5	76	38	—	1.31	1.02
			(2.9)	(3.7)	(0.6)	(0.3)	(0.4)	(0.4)	(7)	(8)	—	(0.50)	(0.07)
	F2	Before	1.0	16.5	0.3	2.9	21.0	37.2	51	43	—	0.99	0.94
			(1.2)	(2.5)	(0.3)	(0.4)	(0.4)	(20.0)	(10)	(8)	—	(0.54)	(0.10)
		After	0.1	2.8	0.0	1.9	22.2	—	40	40	—	0.84	0.97
			(0.1)	(1.5)	(0.1)	(0.5)	(0.5)	—	(13)	(12)	—	(0.58)	(0.08)
	F3	Before	12.4	12.7	3.5	3.1	18.5	27.1	36	21	—	1.19	0.96
			(3.3)	(2.7)	(0.3)	(0.5)	(0.4)	(4.7)	(5)	(3)	—	(0.30)	(0.09)
		After	0.7	1.6	0.7	1.1	22.8	0.7	55	37	—	1.07	0.82
			(0.7)	(1.7)	(0.5)	(0.6)	(1.3)	(1.1)	(9)	(14)	—	(1.15)	(0.17)
	M3	Before	8.0	9.0	1.5	1.8	21.0	10.4	65	56	—	1.22	0.97
			(8.9)	(6.4)	(1.0)	(0.9)	(1.4)	(10.8)	(7)	(13)	—	(0.85)	(0.13)
		After	0.0	0.6	0.0	0.8	23.3	—	71	72	—	1.24	0.94
			(0.0)	(0.3)	(0.0)	(0.2)	(0.2)	—	(9)	(3)	—	(0.01)	(0.07)
2	F4	After	0.1	2.1	0.1	1.6	22.3	0.0	32	34	—	1.24	0.93
			(0.2)	(0.9)	(0.1)	(0.6)	(0.6)	(0.0)	(6)	(7)	—	(0.55)	(0.07)
	F5	After	0.3	4.8	0.2	2.1	21.7	0.0	58	53	—	0.92	0.98
			(0.3)	(3.0)	(0.2)	(0.7)	(0.6)	(0.0)	(3)	(3)	—	(0.49)	(0.06)
	M1	After	1.5	0.2	2.1	0.2	21.9	1.3	—	70	—	—	1.04
			(0.5)	(0.2)	(0.3)	(0.4)	(0.6)	(1.0)	—	(10)	—	—	(0.07)
	M2	After	3.3	1.0	2.3	0.9	20.9	0.3	68	70	—	2.31	1.05
			(1.3)	(0.6)	(0.5)	(0.4)	(0.8)	(0.4)	(9)	(4)	—	(2.91)	(0.08)
3	F6	After	3.8	0.2	2.6	0.1	21.4	0.1	—	69	—	—	1.12
			(1.8)	(0.4)	(0.6)	(0.2)	(0.5)	(0.2)	—	(3)	—	—	(0.07)
	F7	After	5.0	3.6	2.7	2.1	19.4	0.0	76	60	—	1.06	1.08
			(0.5)	(0.9)	(0.3)	(0.3)	(0.4)	(0.1)	(3)	(2)	—	(0.80)	(0.06)
	F8	After	14.8	3.4	2.7	1.6	19.8	0.0	41	27	—	1.83	1.00
			(6.4)	(1.8)	(0.7)	(0.7)	(1.3)	(0.0)	(7)	(6)	—	(1.01)	(0.07)

Note. Main-key rates and reinforcement rates are not shown for stimuli that were present only for periods averaging 0.2 min (about a single presentation) or less.

for each student and each observing phase, using the t test for paired measures. None of the differences was statistically significant (two-tailed ps exceeded .40 in six of eight tests and were .12 and .08 in the others).

Discussion

During the initial observing conditions, 2 of the students reliably preferred S1, whereas the other 2 were indifferent (left panels of Figure 1). After the multiple-schedule conditions, all 4 subjects preferred S1 (right panels of Figure 1). Thus, both before and after discrimination training, stimulus preferences were more in line with those reported by Fantino and Case's group (Case & Fantino, 1989; Case et al., 1985, 1990; Fantino & Case, 1983; Fantino et al., 1983) than by Perone and Baron (1980).

The final preferences for the uncorrelated stimulus developed even though the students had received extended exposure to the stimulus–reinforcer relations under three multiple-schedule conditions (Table 4). In the last of these conditions, mult-simultaneous, S+ and S− were presented in conjunction with the alternating VI and EXT components of the monetary reinforcement schedule, while S1 and S2 also alternated, but without regard to the ongoing component. This put the correlated and uncorrelated stimuli in direct competition for discriminative control over responding on the main key. The results

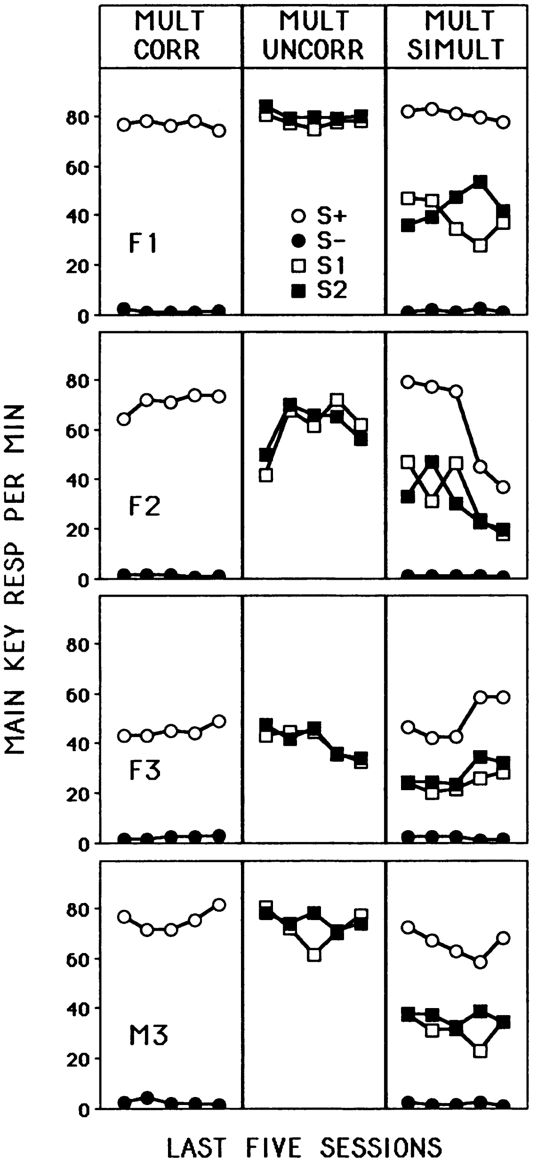

Fig. 2. Experiment 1: Absolute response rates on the main (money-producing) key, in the presence of the various multiple-schedule stimuli, over the last five sessions of the three discrimination training conditions (mult-correlated, mult-uncorrelated, and mult-simultaneous).

established that control was by the correlated stimuli: The students responded at high rates in the presence of S+ and low rates in S−, regardless of whether S1 or S2 happened to be on the screen at the same time (right panels of Figure 2). By the end of discrimination training, then, the students' behavior was controlled by the contents of the upper stimulus box (where S+ and S− were presented) and apparently not at all by the lower box (where S1 and S2 were presented). It seems reasonable to infer that the students were attending to the correlated stimuli and ignoring the uncorrelated stimuli. This pattern of behavior in the multiple-schedule conditions, if continued in the observing conditions, would be reflected in a preference for S−, the stimulus correlated with EXT, over S1, the uncorrelated stimulus. Nevertheless, the opposite preference was obtained.

Two features of the present results seem inconsistent with the delay-reduction hypothesis of conditioned reinforcement. The first problem is the reinforcing strength of the uncorrelated stimulus. According to the hypothesis, uncorrelated stimuli should fail as conditioned reinforcers because they are not reliably associated with improvements in the prevailing schedule of established reinforcement. Second, although all 4 subjects preferred the uncorrelated stimulus, 2 subjects (F1 and F3) responded at relatively high levels on the observing key whose sole consequence was S−. This pattern can be found among Fantino and Case's subjects as well (e.g., Fantino & Case, 1983). According to the delay-reduction hypothesis, however, S− should *suppress* observing because it signals a relative increase in the time to the next monetary reinforcer.

It is possible to resolve these difficulties for the delay-reduction hypothesis by recognizing that stimulus change per se can function as a reinforcer ("sensory reinforcement"; Kish, 1966). Case and Fantino (1981) have argued that the response-enhancing or -suppressing effects that a stimulus derives from its relation with food or money interact with the inherent functions of the stimulus as a sensory reinforcer. By this reasoning, S1 was preferred over S− in the present experiment because the sensory functions of the uncorrelated S1 were at full strength, whereas the functions of S− were reduced by its correlation with extinction.

By comparison with the present results, Perone and Baron (1980, Experiment 3) found that S− was preferred over a physically similar uncorrelated stimulus. Two procedural differences may have contributed to the discrepant results. Perone and Baron gave their subjects discrimination training with the correlated and uncorrelated stimuli at the outset of the experiment, instead of beginning with the ob-

Table 3

Mean responses per minute on the main key in the presence of the various stimuli during the last five sessions of the three discrimination training conditions. Standard deviations are shown in parentheses.

Experiment	Subject	Correlated S+	Correlated S−	Uncorrelated S1	Uncorrelated S2	Simultaneous S+	Simultaneous S−	Simultaneous S1	Simultaneous S2
1	F1	76	1.3	77	80	80	1.4	38	44
		(1)	(0.7)	(2)	(2)	(2)	(0.6)	(7)	(6)
	F2	70	1.0	60	61	63	0.8	33	30
		(3)	(0.4)	(10)	(7)	(18)	(0.2)	(12)	(9)
	F3	45	2.1	40	41	50	1.9	24	28
		(2)	(0.5)	(5)	(5)	(7)	(0.5)	(3)	(4)
	M3	75	2.4	72	75	66	0.7	31	36
		(4)	(1.0)	(6)	(3)	(5)	(0.7)	(5)	(2)
2	F4	37	0.9	13	13	27	0.7	14	13
		(3)	(0.7)	(1)	(1)	(4)	(0.2)	(2)	(2)
	F5	55	1.1	39	37	56	0.9	30	27
		(5)	(0.4)	(3)	(3)	(3)	(0.4)	(5)	(4)
	M1	80	1.6	82	81	79	2.2	40	41
		(2)	(1.3)	(2)	(4)	(3)	(0.3)	(3)	(3)
	M2	62	1.3	68	68	72	0.9	35	38
		(1)	(1.2)	(5)	(5)	(2)	(0.2)	(3)	(4)
3	F6	69	6.6	74	73	74	1.1	36	39
		(4)	(1.5)	(3)	(6)	(3)	(0.7)	(3)	(4)
	F7	79	1.4	34	42	78	1.2	38	41
		(3)	(0.8)	(26)	(30)	(3)	(0.4)	(5)	(3)
	F8	50	3.3	17	21	45	0.5	20	23
		(0)	(5.5)	(8)	(6)	(1)	(0.1)	(6)	(5)

Table 4

Monetary reinforcers per minute earned in the presence of the various stimuli during the last five sessions of the three discrimination training conditions. Standard deviations are shown in parentheses.

Experiment	Subject	Correlated S+	Correlated S−	Uncorrelated S1	Uncorrelated S2	Simultaneous S+	Simultaneous S−	Simultaneous S1	Simultaneous S2
1	F1	1.88	—	0.86	1.08	1.99	—	0.83	1.16
		(0.13)	—	(0.08)	(0.18)	(0.10)	—	(0.07)	(0.16)
	F2	1.97	—	0.96	0.88	1.99	—	1.05	0.95
		(0.18)	—	(0.29)	(0.29)	(0.09)	—	(0.08)	(0.09)
	F3	1.92	—	0.88	0.93	1.94	—	0.83	1.11
		(0.06)	—	(0.24)	(0.20)	(0.09)	—	(0.14)	(0.19)
	M3	1.89	—	0.88	0.93	1.98	—	0.89	1.10
		(0.14)	—	(0.14)	(0.24)	(0.17)	—	(0.18)	(0.09)
2	F4	1.90	—	0.91	0.83	1.84	—	0.96	0.88
		(0.16)	—	(0.17)	(0.16)	(0.10)	—	(0.13)	(0.19)
	F5	1.92	—	0.84	1.00	1.96	—	0.96	1.00
		(0.06)	—	(0.08)	(0.17)	(0.10)	—	(0.15)	(0.16)
	M1	2.06	—	0.81	1.15	2.08	—	1.05	1.03
		(0.11)	—	(0.06)	(0.13)	(0.09)	—	(0.08)	(0.07)
	M2	1.95	—	1.08	0.92	2.07	—	1.01	1.06
		(0.08)	—	(0.29)	(0.23)	(0.12)	—	(0.12)	(0.15)
3	F6	1.93	—	1.06	0.86	1.96	—	0.91	1.05
		(0.08)	—	(0.19)	(0.23)	(0.22)	—	(0.15)	(0.11)
	F7	1.93	—	0.88	0.83	1.97	—	1.03	0.95
		(0.14)	—	(0.31)	(0.23)	(0.07)	—	(0.14)	(0.16)
	F8	1.68	—	0.65	0.72	1.98	—	1.04	0.80
		(0.45)	—	(0.24)	(0.33)	(0.14)	—	(0.29)	(0.37)

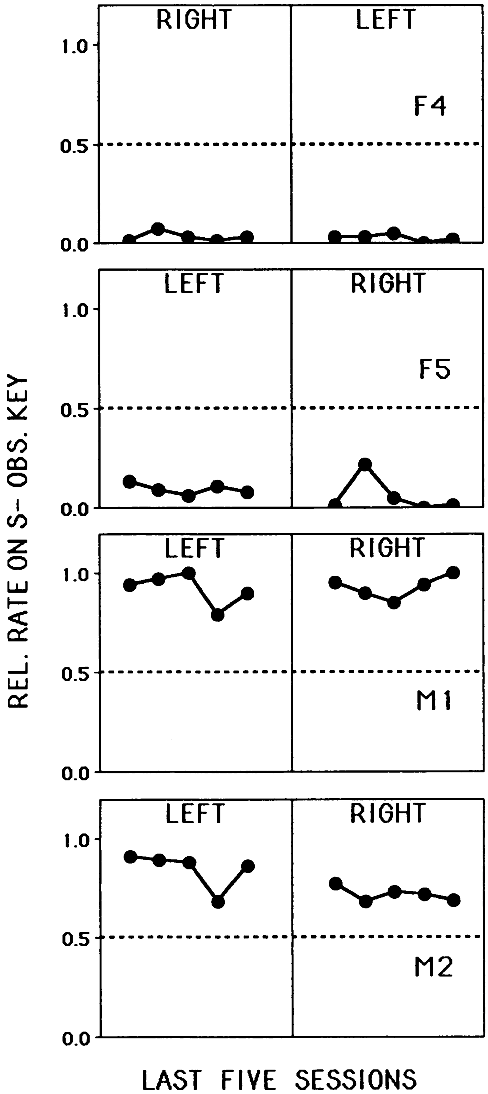

Fig. 3. Experiment 2: Relative rates on the observing key leading to S− over the last five sessions of each condition. Details as in Figure 1.

serving conditions as in the present case. In addition, Perone and Baron used colored lights as discriminative stimuli instead of verbal descriptions of the stimulus–reinforcer relations. The next two experiments were designed to evaluate the role of these procedural variations.

EXPERIMENT 2

In the first experiment, absolute rates of observing were lower after discrimination training than before (Table 2). Although the experimental design precludes firm conclusions about the reasons for this, it is plausible that the concentrated exposure to the stimulus–reinforcer relations during discrimination training reduced the effectiveness of the stimuli as instructions. The second experiment was designed to strengthen the potential influence of discrimination training by using it to establish the students' initial contact with the stimuli, so that the stimulus–reinforcer relations programmed within the experiment itself might be more likely to override any instructional functions arising from the verbal content of the stimuli.

METHOD

Four students (2 women and 2 men) participated. The only difference from Experiment 1 was that the initial observing phase was omitted. Thus, Experiment 2 began with discrimination training using the verbal stimuli shown in the upper part of Table 1, with a block of sessions devoted to each of the three multiple-schedule conditions: mult-correlated (9 to 15 sessions), mult-uncorrelated (5 to 7 sessions), and mult-simultaneous (7 to 13 sessions). These were followed by two observing conditions. In the first, pressing one key produced S1 and pressing the other produced S− (6 to 11 sessions); in the second, the consequences were reversed (6 to 8 sessions).

RESULTS

Results from the observing conditions are summarized in the form of relative observing rates in Figure 3 and absolute rates and stimulus production times in Table 2. By all three measures, 2 students (F4 and F5) preferred S1, but the other 2 (M1 and M2) preferred S−. Absolute rates were low—less than five responses per minute on the preferred key and usually less than one on the other key. Comparison of these rates, obtained after discrimination training, with those in Experiment 1 (also in Table 2) shows that they are more similar to the rates obtained after discrimination training than the higher rates obtained before training.

Rates of main-key responding and monetary reinforcement in the discrimination training conditions are shown in Tables 3 and 4, and rates in the subsequent observing conditions are shown in Table 2. The pattern of results was essentially the same as that described for the comparable conditions in Experiment 1. Main-key rates were high in S+ and low in S−, and were undifferentiated in S1 versus S2. Reinforcement rates in each stimulus were close to the programmed rates, although variability in the S1 rates was higher in the observing conditions when this stimulus appeared only intermittently. The reinforcement rates during the response-produced presentations of S1 did not differ in a statistically significant way from those during the MIX stimulus (t test for paired measures; two-tailed ps ranged from .25 to .72).

DISCUSSION

Stimulus preferences were consistent within subjects but inconsistent across subjects, with 2 preferring S1 as in Experiment 1 and 2 others preferring S− as in research by Perone and Baron (1980). The emergence of the latter preference—for a stimulus indicating that "no scores can be earned" over a stimulus promising that "some of this time scores are twice as likely as normal"—suggests that the initial discrimination training may have been somewhat successful in reducing instructional control by the stimuli. The fact that half the subjects still preferred the uncorrelated stimulus may be seen as the outcome of individual differences, either in susceptibility to the conditioning procedures or in the strength of the subjects' disposition to obey the instructional content of the stimuli, or both.

It is possible, however, that the subject differences in stimulus preference had nothing to do with the timing of the discrimination training in Experiments 1 and 2. Another interpretation, equally plausible, is that the verbal content of the stimuli remained functional for all of the subjects, but that the nature of the control differed. For subjects preferring S1, the stimuli may have functioned roughly as *mands*, telling which observing key to press. Because S1 promised the possibility of scores and S− eliminated this possibility, the S1 and S− messages may have been functionally equivalent to "yes" and "no," "go" and "stop," or "do" and "don't." Under such circumstances, it seems likely that "go" would be preferred over "stop." By comparison, for subjects preferring S−, the stimuli may have functioned roughly as *tacts*, providing information about the nature of the contingencies without implying a course of action. S− would be equivalent to "the system is off" and S1 to "the system might be on or it might be off." In this case, the S− would seem to have the advantage in maintaining attention.

The distinction drawn here is based on Skinner's (1957) functional analysis of exchanges between a speaker and a listener—in this case, the experimenter and subject, who might be identified in more operational terms as writer and reader. Although Skinner's analysis focuses on the speaker's verbal behavior, the emphasis here is on the effect on the listener of the resulting verbal stimulus. In analysis of verbal behavior that does emphasize the listener, Zettle and Hayes (1982) distinguished between *plys* and *tracks*, which in many cases may be regarded as the listener's counterparts to a speaker's mands and tacts. Zettle and Hayes, however, were concerned exclusively with rule-governed behavior, and their distinction was based on the factors controlling the correspondence between a rule and the listener's behavior. The present concern is not with distinguishing among various kinds of rule following, but rather with distinguishing between cases in which listeners follow rules or commands (as in responding to a mand) or merely monitor the state of the environment (as in attending to a tact).

Regardless of whether the focus is on the speaker or the listener, classifying the elements of a verbal episode requires more information about the episode than can be obtained by examining only the structure or content of the verbalizations. Consider an exchange between two diners, one of whom says "The soup needs salt." This statement could function as a mand or tact, but a decision might be possible by observing the rest of the episode. If, for example, the listener passed a salt shaker to the speaker, one might safely infer that the statement functioned as a mand akin to "Pass the salt." But if the listener merely replied "You're right," it would be safer to classify the statement as a tact.

The nature of a listener's response is determined not only by the structure of the verbal stimuli but also by the history of social reinforcement and punishment arranged by the community in conjunction with such stimuli. In the present research, the S1 and S− messages may be seen as tapping a verbal repertoire established before the experiment. It would not be surprising if the strength of that

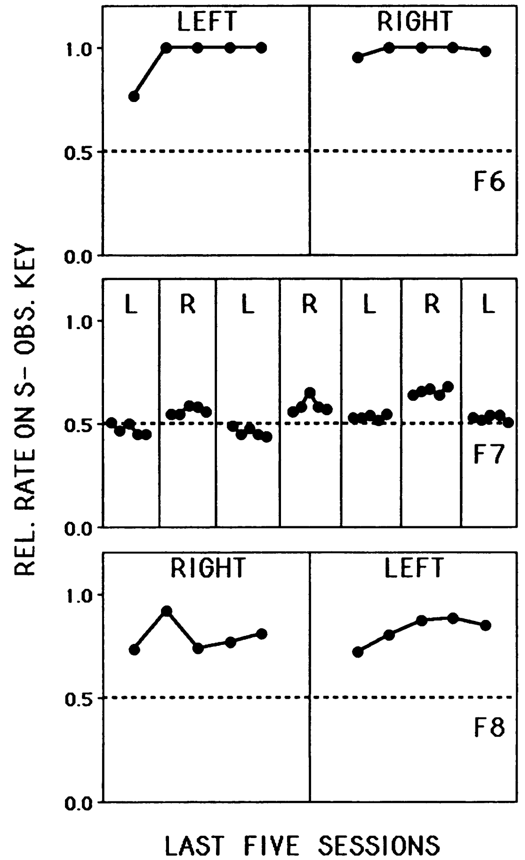

Fig. 4. Experiment 3: Relative rates on the observing key leading to S− over the last five sessions of each condition. Details as in Figure 1.

repertoire and the length of the history that led to it overcame the relatively weak contingencies arranged within the experiments. Worth noting is that the monetary reinforcers were independent of the subjects' stimulus preferences; thus, any pattern of observing behavior could be accommodated or perhaps even reinforced, albeit indirectly, by near-optimal earnings. This is in marked contrast to the procedures of experiments in which contingencies compete more successfully with instructions; in those procedures, instruction-appropriate responding leads to reduced reinforcement rates (e.g., Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Torgrud & Holborn, 1990) or even punishment (Galizio, 1979).

EXPERIMENT 3

To reduce the role of preexperimental history, and thus the possibility of instructional control, the descriptive verbal stimuli were replaced with arbitrary ones. Instead of describing the VI and EXT components of the monetary reinforcement schedule, these messages labeled them "A" and "B" or, in the case of the uncorrelated stimuli, "either A or B" and "either B or A."

METHOD

Three female students participated. As in Experiment 2, the students were given discrimination training with the correlated and uncorrelated stimuli, singly and in combination, before observing tests compared the functions of S− and S1. The major difference was the use of the arbitrary verbal stimuli listed in the lower half of Table 1. In an effort to expedite the discrimination training phase, presentations of the VI and EXT components were lengthened during the first three sessions of the mult-correlated condition. The presentations lasted 12 min each in the first session and 24 min in the second and third (the second session was devoted to VI and the third to EXT). This modification, used with Subjects F7 and F8, had no apparent effect on the acquisition of the discrimination between S+ and S−. There were 11 to 24 sessions in the mult-correlated condition, 5 to 15 in mult-uncorrelated, and 7 to 15 in mult-simultaneous. The first observing condition lasted 5 to 15 sessions; subsequent conditions lasted 5 to 7. For 2 students (F6 and F8), stimulus preferences were apparent after a single reversal of the stimulus consequences associated with the observing keys; five additional reversals were conducted to clarify the preference of the remaining subject.

RESULTS

Results from the observing conditions are summarized in the form of relative observing rates in Figure 4 and absolute rates and stimulus production times in Table 2. By every measure, all 3 students preferred S−. Preferences of Subjects F6 and F8 were clear from the outset. Subject F7's preference was weaker and was obscured by a strong bias for the right key, as shown by the fluctuation in her observing rates across the reversals in Figure 3. Over the last four conditions, however, she showed a small but consistent preference for S− in spite of this bias.

Rates of main-key responding and monetary reinforcement in the discrimination training conditions are shown in Tables 3 and 4, and rates in the observing conditions are shown in Table 2. As in Experiments 1 and 2, main-key rates were high in S+ and low in S−, and were undifferentiated in S1 versus S2. Reinforcement rates in each stimulus were close to the programmed rates, albeit with greater variability in the S1 rates during the observing conditions. Comparisons of the reinforcement rates in the S1 versus the MIX stimulus indicated a statistically significant difference in the case of Subject F8, $t(9) = 2.41$, $p = .04$, but not for F7, $t(9) = 0.10$, $p = .92$ (the remaining subject, F6, did not produce S1 often enough to permit comparison). It is noteworthy that F8's preference for S− over S1 developed even though S1 signaled an improvement in the rate of monetary reinforcement for this subject.

Discussion

This experiment confirms Perone and Baron's (1980) finding that a stimulus correlated with extinction can reinforce observing in adult humans, and extends the generality of the finding across subjects (male and female college students in the present case vs. male industrial workers in the earlier research), stimuli (verbal messages vs. colored lights), and response requirements on the primary schedule (pressing a light key vs. pulling a heavy plunger).

As in Perone and Baron's (1980) research, the EXT component alternated with a response-dependent schedule of monetary reinforcement; thus, it is necessary to consider the possibility that S− derived its reinforcing function from a correlation with reduced effort. Several points argue against such an account. First, all of the response keys had identical force requirements, so no effort could be saved by pressing the observing keys instead of the main key during MIX stimulus conditions. Second, the force requirement was minimal (0.5 to 0.9 N, depending on the exact point of contact with the key). Even large changes in response efficiency might not produce meaningful differences in effort. Third, the requirement was held constant, so any change in effort that might have accompanied production of S− in the third experiment, when S− was the preferred stimulus, was also available in the first experiment, when S− was not preferred. If effort reduction was responsible for the reinforcing functions of S−, one might expect to see more consistent preferences across the experiments. Finally, the degree to which stimulus production might affect the efficiency of main-key responding was limited by the intermittent observing schedules, which allowed the stimuli to be present no more than 33% of the time (10-s stimulus presentations could occur at intervals averaging 20 s). Furthermore, producing one of the stimuli, S1, would confer no advantage because this uncorrelated stimulus signaled no change from the prevailing MIX conditions (see Tables 1 and 2). Although S− signaled a period in which responding could cease without losing money, this stimulus was available for only 4 min of the 12 min spent in the EXT component, and the responding required to produce the stimulus could easily offset any savings made possible by its occasional presence.

Information on the distribution of effort in the present experiments can be found in Table 5, which shows the average number of responses emitted during the stable sessions. Several patterns are evident. In discrimination training, when only the main key was operative, the response output of most subjects was lower when the correlated stimuli were present (mult-correlated and mult-simultaneous conditions) than when they were absent (mult-uncorrelated condition). This reflects the efficiency made possible when S− always accompanied the EXT component. In the observing phases, when S− was necessarily absent most of the time (see Table 2 for details), most subjects again pressed the main key more than in the multiple-schedule conditions with S− fully present. Thus, observing did not support especially efficient main-key responding, and this held true regardless of the subject's stimulus preferences (compare the top 6 subjects in Table 5, who preferred S1, with the bottom 5, who preferred S−).

Perhaps the most straightforward comparison of the data in Table 5 is between the total response output in the mult-uncorrelated condition (all responding on the main key) and the subsequent observing condition (combined responding on the main and observing keys). This allows evaluation of the change in overall effort from a condition in which no correlated stimuli are present (mult-uncorrelated) to one in which the correlated S− may be produced by additional responding. Output of Subjects F1, F2, M1 and F6 was lower in the observing

Table 5

Mean responses per session (and standard deviations in parentheses) on the main and observing keys during the observing conditions before and after discrimination training, and on the main key during the three conditions of discrimination training. The observing statistics are collapsed across the last five sessions in each of the final two observing conditions in each phase (for a total of 10 sessions per statistic); the discrimination statistics are based on the last five sessions of each condition.

Experi-		Before			Discrimination			After		
ment	Subject	Main	Obs	Total	Corr	Uncorr	Simult	Main	Obs	Total
1	F1	1,002	633	1,635	935	1,895	985	928	559	1,487
		(143)	(98)	(106)	(16)	(40)	(24)	(165)	(69)	(193)
	F2	1,061	366	1,428	866	1,467	764	956	63	1,019
		(178)	(61)	(172)	(39)	(204)	(217)	(279)	(29)	(282)
	F3	586	462	1,048	567	976	622	898	49	947
		(63)	(66)	(117)	(29)	(122)	(84)	(333)	(48)	(356)
	M3	1,329	344	1,673	934	1,770	814	1,737	15	1,752
		(302)	(208)	(127)	(38)	(84)	(56)	(55)	(7)	(56)
2	F4	—	—	—	452	315	328	819	50	869
		—	—	—	(47)	(26)	(48)	(149)	(21)	(132)
	F5	—	—	—	677	916	680	1,283	111	1,393
		—	—	—	(66)	(64)	(28)	(63)	(57)	(112)
	M1	—	—	—	983	1,964	972	1,554	36	1,590
		—	—	—	(30)	(60)	(36)	(201)	(12)	(208)
	M2	—	—	—	765	1,631	874	1,527	87	1,614
		—	—	—	(25)	(110)	(22)	(104)	(29)	(90)
3	F6	—	—	—	913	1,759	905	1,469	85	1,553
		—	—	—	(50)	(95)	(28)	(47)	(41)	(38)
	F7	—	—	—	965	905	951	1,325	166	1,491
		—	—	—	(39)	(678)	(43)	(57)	(19)	(68)
	F8	—	—	—	591	461	538	615	331	946
		—	—	—	(59)	(153)	(29)	(117)	(125)	(55)

condition (78%, 69%, 81%, and 88% of mult-uncorrelated responding, respectively). For Subjects F3, M3, and M2, output was about the same (97%, 99%, and 99%, respectively), and that of Subjects F4, F5, F7, and F8 increased (276%, 152%, 165%, and 205%). These different degrees of change were not related to the subjects' stimulus preferences. Expressed as a percentage of responding during the mult-uncorrelated condition, the average output during the observing condition did not differ between subjects who preferred S1 (top 6 subjects in Table 5; median = 98%, mean = 129%, *SD* = 71%) and those who preferred S− (bottom 5 subjects; median = 99%, mean = 128%, *SD* = 49%). Clearly, overall response effort was not reduced consistently by observing either S− or S1. This finding is in line with previous results showing the maintenance of observing in humans even when it involves increased effort (Baron & Galizio, 1976; Galizio, 1979).

An experiment by Case and Fantino (1989, Experiment 3) appears to have involved a strategy similar to that of Experiment 3. As in the present work, Case and Fantino withheld their usual instructions about the stimulus–reinforcer relations and instead provided discrimination training before testing stimulus preferences in an observing phase. But several aspects of Case and Fantino's study sharply limit the comparisons that can be drawn between their study and the present one. Discrimination training was brief, lasting no more than three sessions, and did not involve the full range of correlated and uncorrelated stimuli. The basis for ending discrimination training was not the establishment of stimulus control over instrumental responding; instead, the subjects had to describe the stimulus–reinforcer relations in response to open-ended questions from the experimenter. With such a procedure, it is impossible to decide whether stimulus functions should be ascribed to the direct exposure provided in the laboratory (however limited it may have been in this case), to the verbal exchanges between the subject and experimenter, or to some combination.

To complicate matters further, Case and Fantino's (1989, Experiment 3) results are expressed as group averages for 22 subjects given substantially different treatments. With regard to the primary schedules, some subjects were trained with two VI components that differed in terms of the magnitude of the monetary reinforcers. Others were trained with components in which the reinforcers were presented independently of responding on variable-time (VT) schedules. Still others were trained with VT and EXT components. With regard to the observing schedules, some subjects chose between S+ and S−, whereas others chose between an uncorrelated stimulus and S−. In most cases the S− was associated with the lesser of two monetary reinforcers rather than with EXT, and none of the subjects chose between an uncorrelated stimulus and an EXT-correlated stimulus—the comparison of present interest.

GENERAL DISCUSSION

In Experiments 1 and 2, the discriminative stimuli were descriptions of the stimulus–reinforcer relations derived from instructions used by Fantino and Case (1983). An S− stating that "At this time NO SCORES can be earned" was relatively ineffective as a reinforcer of observing. Instead, most subjects preferred an uncorrelated stimulus stating that "Some of this time scores are TWICE AS LIKELY as normal, and some of this time NO SCORES can be earned." This result replicates findings from Fantino and Case's laboratory (Case & Fantino, 1989; Case et al., 1990; Fantino & Case, 1983; Fantino et al., 1983). In Experiment 3, the stimuli bore an arbitrary relation to monetary reinforcement. An S− stating that "The Current Status of the Program is: B" was preferred over an uncorrelated stimulus stating that "The Current Status . . . is: either A or B." This result supports Perone and Baron's (1980) finding that a stimulus correlated with extinction can reinforce human observing.

The differences in maintenance of observing by the descriptive and arbitrary messages may be attributed to differences in instructional control by these stimuli. Because of the human subject's preexperimental history in a verbal community, descriptive messages may control behavior independently of laboratory contingencies. Thus, a message promising that money might be earned (Experiments 1 and 2) or a stimulus paired with such an instruction (Fantino and Case's research) maintains observing even though it signals no change from the prevailing schedule conditions. By comparison, arbitrary messages might not tap the subject's history, at least not to the same extent. Their functions, like those of other arbitrary stimuli such as colored lights unadorned by explicit instructions, may be more susceptible to manipulation within the laboratory by direct exposure to the reinforcement conditions they accompany. Under these conditions of weakened instructional control, adults observe messages (Experiment 3) or lights (Perone & Baron, 1980) correlated with extinction, even when such behavior produces no reduction in overall response effort.

Another way of characterizing the difference between the descriptive and arbitrary stimuli is in terms of the degree of contact they fostered with the mixed schedule of monetary reinforcement—in other words, how well the stimuli tacted the schedule conditions. The argument here is that both sets of stimuli exerted instructional control, but the nature of the control differed. In Experiments 1 and 2, the stimulus boxes were blank unless an observing key was pressed, whereupon a descriptive message appeared. Most subjects behaved as they might if their responding actually produced the schedule conditions the stimuli described. Thus, 6 of 8 subjects preferred the stimulus instructing them that money might be earned. In Experiment 3, the stimulus boxes indicated that the status of the program was "not shown." Presses on the observing key replaced this message with others that showed the program's status, but with different degrees of certainty. In this case, all 3 subjects tended to respond in such a way as to change the environment from one of uncertainty (status is "not shown") to certainty (status is "B"), rather than moving from one form of uncertainty ("not shown") to another ("either A or B"). By comparison with the descriptive messages, the phrasing of the arbitrary messages seems more likely to have fostered discrimination of the informational value of S− and the lack of such value in S1.

In any case, the present research suggests that human behavior can be susceptible to reinforcement by information under some circumstances, at least when the subjects are adults. The S− was informative because of its reliable correlation with monetary reinforcement; the fact that the correlation was negative may make the S− "bad news," but it remains news nevertheless. This observation—that informative stimuli may function as conditioned reinforcers—should not be taken to imply that stimuli become conditioned reinforcers *because* they are informative. Indeed, this latter viewpoint, the "information hypothesis" (Hendry, 1969), has been thoroughly discredited, and it seems fair to say that no experiment with nonhumans has provided convincing support for it. Although two studies with monkeys are sometimes cited in support (Lieberman, 1972; Schrier, Thompson, & Spector, 1980), both are open to alternative explanation (Dinsmoor, 1983; Dinsmoor et al., 1972; Fantino, 1977; Mueller & Dinsmoor, 1984, 1986).

A satisfactory theoretical explanation for the phenomenon of reinforcement by information remains to be developed. But we hope that the explanation will be in line with the Pavlovian accounts that have been so successful in explaining the results of experiments with nonhumans. As noted elsewhere (Perone & Baron, 1983), perhaps the most productive reaction to the research with humans would be to accept the evidence for reinforcement by information at face value, and then take up the challenge of showing that this phenomenon is a product of Pavlovian processes rather than a competing principle of behavior. For example, negative discriminative stimuli might become reinforcing, ultimately, through a Pavlovian association with reinforcement provided by a verbal community that shapes attention to a variety of environmental events regardless of their immediate hedonic value. In line with this general approach, Allen and Lattal (1989) demonstrated that pigeons' observing is sensitive to molar relations involving responses and consequences occurring over extended time frames. Furthermore, outside the literature on observing, several studies have shown that the functions of discriminative stimuli are affected by the broader context in which training takes place, including events in the remote history of the subject (e.g., Rilling, Kramer, & Richards, 1973; Terrace, 1971).

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